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Cooperative study between the
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THE AUTHORS

ALLEN D. BRUNER is a Range Research Associate with the Renewable Natural Resources Division, Max C. Fleischmann College of Agriculture, University of Nevada, Reno. He received his B.S. degree (1961) in crop production from California Polytechnic College and his M.S. degree (1967) in range management from the University of Nevada. He has been in his present position since 1969.

DONALD A. KLEBENOW is an Associate Professor of Wildlife with the Renewable Natural Resources Division, Max C. Fleischmann College of Agriculture, University of Nevada, Reno. He received his B.S. degree (1960) in forestry and his M.S. degree (1962) in wildlife management at the University of Montana; his Ph.D. degree (1968) in wildlife ecology was received at the University of Idaho. He was Assistant Professor at Texas Tech University from 1968 to 1971 and has been in his present position since 1971.

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RESEARCH SUMMARY

Prescribed burning is an inexpensive management tool which can be used for converting pinyon-juniper woodlands to brush-grassland communities that benefit wildlife and livestock grazing. One of the difficulties of prescribed burning is predicting whether or not conditions are right for a successful burn. In this study, 30 prescribed burns were attempted out of fire season from fall 1974 to fall 1976. These attempts were made during varied atmospheric conditions and in several pinyon-juniper communities, but only 12 of the 30 attempts were successful. An analysis of the burns showed that the success of a burn could be predicted accurately (89 percent) by adding together the maximum windspeed in miles per hour, the air temperature in degrees Fahrenheit, and the percentage of vegetation cover (windspeed [mi/h] + air temperature [°F] + vegetation cover [percent] = score). If the score thus obtained was less than 110, the fire would not burn; if it was greater than 130 it was too hazardous to light. Scores between 110 and 125 produced fires which needed continual retorching, and scores between 126 and 130 produced fires that carried by themselves and created clean burns. Fires were most successful in dispersed, scattered and dense pinyon-juniper stands, less successful in open and closed stands. The best ignition technique was to have two people walk perpendicular to the wind along the windward edge of the area to be burned headfiring and ignite trees using smudge pot lighters.

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INTRODUCTION

Pinyon pine (*Pinus monophylla*) and juniper (*Juniperus osteosperma*) occupy approximately 14 percent of Nevada (Blackburn and Tueller 1970). Invasion of pinyon-juniper possibly due to past overgrazing and fire suppression often results in the elimination of understory vegetation. This in turn decreases forage for livestock and wildlife. Prescribed burning is an inexpensive method of converting small portions of pinyon-juniper vegetation to brush-grassland communities that benefit both wildlife and livestock grazing (Aro 1971).

Most of the woodlands in Nevada have a large degree of nonuniformity due to the abruptly changing topography, soil depth, aspect, and elevation. This nonuniformity provides many natural firebreaks in most pinyon-juniper stands and makes it easy to delineate areas for prescribed burning.

This report provides burning guidelines for using prescribed fire as a management tool in pinyon-juniper communities. The various pinyon-juniper communities have been segregated and recommendations are made as to which communities are most responsive to fire. From 1974 to 1976, 30 attempts were made to burn pinyon-juniper vegetation in the spring and fall. Twelve of these attempts were successful in that the fire carried beyond the ignition area through the vegetation leaving few if any unburned areas or islands. The best ignition methods were determined, and a simple method for determining burning success prior to ignition was developed from analyses of these burns.

METHODS

Burning attempts were made out of fire season at three locations: White River in the White Pine District and Cherry Springs in the Lamoille District of the Humboldt National Forest; and Blackwell Canyon in the Bridgeport District of the Toiyabe National Forest (fig. 1). The majority of attempts and all the successful burns were in the White River area.

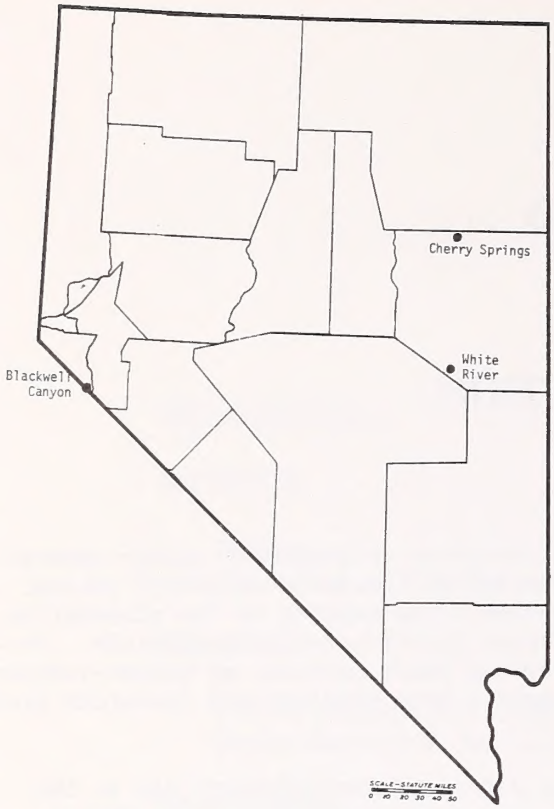

Figure 1.--Areas of experimental burning attempts from fall 1974 to fall 1976.

Ignition

Three tools for igniting trees were compared--conventional drip torches, flamethrowers, and the orchard heater lighter. The latter, also called the smudge pot lighter, was found to be the ideal tool (Bruner 1977) because its long spout gives a good pouring balance and provides some distance between the user and the flame. It emits a heavy stream of fuel which, when mixed 50-50 (50 percent gasoline and 50 percent diesel oil), remains burning on the bark or needles for 10 to 20 seconds. To ignite a tree, pour a heavy stream of burning fuel up and down the trunk from the ground up to 5 or 6 feet. The dead needles on the ground and any shrubs under the tree should be ignited while backing out from under the canopy on the windward side. By directly lighting several trees, the ambient temperature of the area increases rapidly and understory plants are ignited. It is this initial torch of several trees producing a flame length of 20 to 30 feet that is necessary to develop a fire which will carry and create a clean burn (fig. 2). Heat and flame are not generated fast enough if only the shrubs are lit, especially those in the tree interspaces. Two safety precautions of the tool are: gasoline must be well mixed with diesel oil and the antiflashback screen must be present in the spout.

Several techniques have been tried in igniting pinyon-juniper stands. The best method is to have two people walk perpendicular to the wind along the windward edge of the area to be burned (headfiring). The lead person can either leave unlit holes for the following person to light, or the two people can leap frog past one another. Either way, this has been the easiest and the most efficient way to start pinyon-juniper fires.

Figure 2.--A dense pinyon-juniper community after a clean burn. Conditions the day of this burn added to the simple score of 126.

Evaluation of Fire Success

The degree of success of each burn varied considerably in the 30 burning attempts (table 1). Objective rating of burn success is difficult in these highly volatile pinyon-juniper vegetation types; the consumption of fuel by the fire seems to be the same whether the fire carries well or whether only the immediate ignition area burns. For this reason, the success rating falls into three simple categories: (1) after the ignition area is lit, the fire carries by itself, burning the area clean, with only some retorching necessary; (2) the ignition area needs to be continually lit during the entire burn period and some unburned islands occur; (3) the fire does not carry beyond the ignition area.

RESULTS

Pinyon-Juniper Communities

When discussing prescribed fire it is important to categorize the various pinyon-juniper communities. Blackburn and Tueller (1970) describe five general communities of pinyon-juniper and give a species cover percentage for each named community. By adding a range of percent tree cover to those named communities, the following divisions were made: 0-2 percent open, 2-9 percent dispersed, 9-23 percent scattered, 23-35 percent dense, and 35+ percent closed.

Table 1.--*Summary of atmospheric conditions, soil and plant moisture, and burning success for 30 burning attempts in the White River, Cherry Springs, and Blackwell Canyon study areas from 1974 to 1976*

Burn date	Location	Time[1]	Burning conditions: Temperature	Burning conditions: Relative humidity	Burning conditions: Wind speed	Burning conditions: Soil moisture[2]	Burning conditions: Plant moisture[3]	Burn success[4]	Area burned
			°F	*Percent*	*Mi/h*	*Percent*	*Percent*		*Acres*
17 Nov 74	White River	1315	51	26	0-10	--	--	2	2
18 Nov 74	White River	1230	53	27	8-12	--	--	3	
24 Apr 75	White River	1400	60	26	5-25	13	50	1	18
2 May 75	White River	1445	58	20	0- 8	12	48	2	9
3 May 75	White River	1100	56	26	0-10	12	48	2	
9 May 75	White River	1510	65	16	2- 8	12	50	1	19
16 May 75	White River	1030	65	14	0- 5	12	49	2	3
28 May 75	Cherry Spgs	1430	53	32	3-10	13	54	3	
29 May 75	Cherry Spgs	1300	65	20	0-10	13	54	3	
12 Jun 75	White River	1400	77	8	0-12	9	47	1	9
17 Jun 75	Cherry Spgs	1200	54	90	0- 5	10	49	3	
24 Jun 75	Cherry Spgs	1215	67	5	10-35	8	49	3	
24 Jun 75	Cherry Spgs	1430	56	35	0- 5	8	49	3	
26 Jun 75	Cherry Spgs	1145	65	26	0- 8	8	48	3	
26 Jun 75	Cherry Spgs	1500	74	16	0- 6	8	48	3	
9 Oct 75	White River	1300	53	18	0-10	9	38	2	8
26 Oct 75	Cherry Spgs	1100	51	40	5-20	17	35	3	
15 Nov 75	White River	1400	55	12	0- 7	3	--	2	3
3 May 76	Blackwell Canyon	1300	78	7	0- 8	--	42	0	
10 May 76	White River	1720	70	17	0- 8	11	53	3	
11 May 76	White River	1630	70	23	0-10	11	53	3	
17 May 76	White River	1330	72	19	0-12	--	--	1	60
27 May 76	White River	1515	78	17	3-15	6	--	3	
28 May 76	Cherry Spgs	1400	72	19	2-12	5	--	3	
28 May 76	Cherry Spgs	1730	65	9	5-20	5	--	3	
22 Jun 76	White River	1600	66	20	6-18	2	46	1	25
23 Jun 76	White River	1500	71	12	4-15	2	46	1	45
9 Nov 76	White River	1300	56	28	0- 8	7	49	1	6
10 Nov 76	White River	1430	50	40	0	7	49	3	
9 Dec 76	White River	1130	36	52	2-10	11	49	3	

[1]Time at ignition.
[2]Sample 0-4 inches deep.
[3]Percent of green weight pinyon.
[4]0 = too hazardous to light; 1 = fire carried, clean burn; 2 = fire needed lighting assistance; 3 = would not burn.

Three of these five communities are unsuitable for prescribed burning. The open and dispersed communities (fig. 3) are excluded because of the small degree of influence the trees have on the understory vegetation of these communities. The closed stands (fig. 4) are excluded because of the difficulty in burning them out of fire season. Closed communities have few understory shrubs; consequently, hazardous conditions capable of producing a crown fire are necessary before these communities will burn successfully. Ten attempts to burn closed stands in this study were unsuccessful. One attempt (table 1, 24 June 75, 12:15) was made during hazardous conditions but still failed to carry the fire. Because of the hazards, closed stands should be pretreated by chaining, windrowing, or other means before attempting to burn them.

Two communities remain on which burning might best be concentrated--scattered and dense (fig. 5). Blackburn and Tueller (1970) state that the scattered community appears to be the point in the invasion pattern where pinyon and juniper start to exert their influence and begin to dominate the understory species. This causes a sharp reduction in the vigor and frequency of the understory. Pinyon and juniper in dense communities exert even more influence, dominating the understory to an even greater extent.

Figure 3.--Open pinyon-juniper communities (top) and dispersed pinyon-juniper communities (bottom) are not recommended for burning because trees are too sparse to have much influence on the understory vegetation.

Figure 4.--Closed pinyon-juniper communities are extremely difficult to burn out of fire season.

Figure 5.--Scattered pinyon-juniper community (top) and dense pinyon-juniper community (bottom). Many successful burns occurred in these vegetation types.

Prediction of Fire Success

There are many variable conditions at the time of each burn (table 1). Many of the atmospheric conditions compensate for each other; a low value of one can be offset by a high value of another. When maximum windspeed, air temperature, and percent vegetation cover are added together, this composite score becomes a good indicator of burning success in the scattered and dense pinyon-juniper communities (table 2). The score

Table 2.--*Composite score and burn ratings during 1974-76 burns at White River and Blackwell Canyon, Nevada*

Burn date	Windspeed	Temperature	Vegetation cover	Score[1]	Simple score rating[2]	Discriminant analysis rating[3]	Actual rating
	Mi/h	*°F*	*Percent*				
No burn prediction (score <110)							
9 Dec 76	10	35	49	94	3	3	3
10 Nov 76	0	50	51	101	3	3	3
Continual retorching necessary (score 110-125)							
15 Nov 75	7	55	56	118	2	2	2
9 Oct 75	10	53	56	119	2	2	2
16 May 75	5	65	50	120	2	2	2
10 May 76	8	70	43	121	2	3	3
2 May 75	8	58	56	122	2	2	2
3 May 75	10	56	56	122	2	2	2
Clean burn prediction (score 126-130)							
9 Nov 76	8	55	63	126	1	2	1
17 May 76	12	72	43	127	1	1	1
27 May 76	6	78	43	127	1	2	3
22 Jun 76	18	66	43	127	1	1	1
17 Nov 74	10	51	66	127	1	1	1
9 May 75	8	65	55	128	1	2	1
23 Jun 76	15	71	43	129	1	1	1
12 Jun 75	12	77	42	130	1	1	1
Hazardous burning conditions (score >130)							
24 Apr 75	25	60	46	131	[4]1	1	1
3 May 76	8	78	48	134	0	--[5]	--[5]

[1]Score is derived by using the following formula: maximum windspeed (mi/h) + temperature (°F) + percent vegetation cover = score.

[2]3 = no burn (score <110); 2 = continual retorching necessary (score 110-125); 1 = clean burn, fire carries (score 126-130); 0 = too hazardous to burn (score >130).

[3]From Klecka (1975).

[4]This burn made one short run outside of the intended boundaries. It was felt that we were very close to or into the hazardous conditions for burning.

[5]The USFS Class I Fire Boss would not allow ignition this date, so no comparative or actual ratings were made.

is derived by simply adding maximum windspeed in miles per hour, air temperature in degrees Fahrenheit, and vegetation cover in percent (wind mi/h + °F + percent veg. cover = score). If metric measurements are used the formula is 0.6 (km/h) + 1.8 (°C) + percent veg. cover + 32 = score.

Considering the three fire class ratings of 1, 2, and 3 (table 2), a score of less than 110 will not provide conditions necessary for burning (class 3). A score of 110 to 125 indicates conditions prevail for a class 2 fire. A score of 125 to 130 indicates conditions are optimum for a class 1 or self-sustaining fire that will carry itself

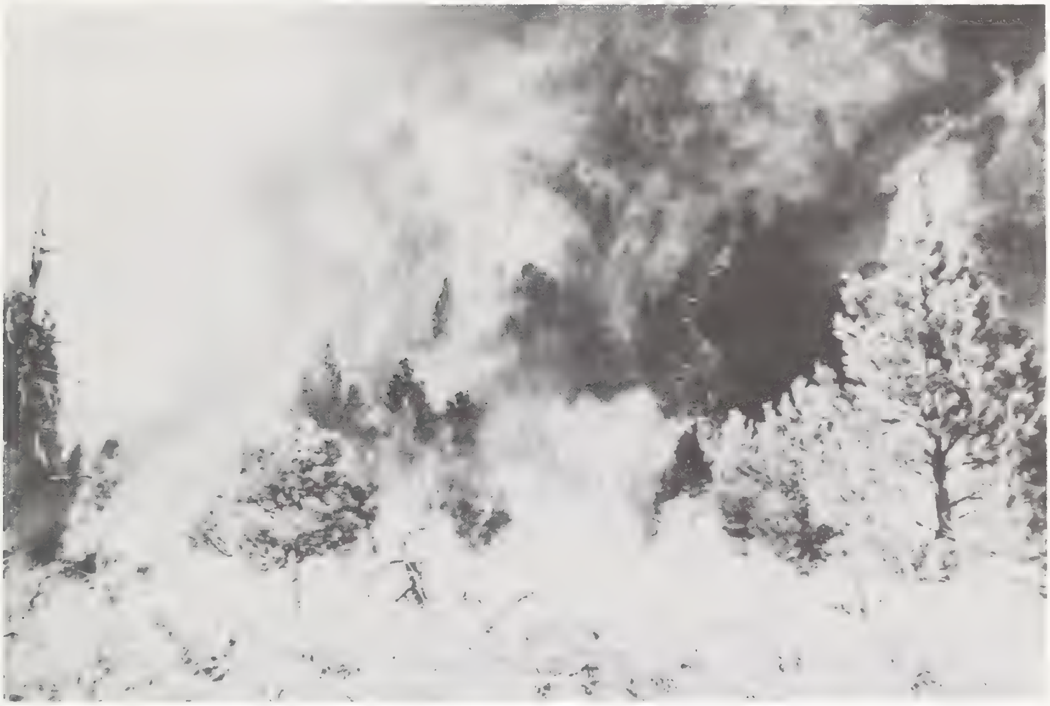

Figure 6.--A class 1 or self-sustaining fire capable of carrying through the vegetation. May 9, 1975, burn at White River, Nevada.

(fig. 6). A score higher than 130 indicates a hazardous condition in the scattered and dense pinyon-juniper communities when burning should not be attempted.

When these simple scores were compared on 17 burns (table 2), 15 of the 17 (88 percent) were correctly classified. A discriminant analysis (Klecka 1975) was used to construct a weighted score of the variables--wind, temperature, and cover--to separate the burns into three classes. This more sophisticated method correctly classified 82 percent of the burns. With more observations, these results would change; however, the simple score method compares very favorably with the discriminant analysis.

This simple scoring applies to the cooler months of April, May, October, and November, or anytime when air temperatures are below 75°F and windspeeds are above 5 mi/h. Total vegetation cover varied from 42 to 66 percent on all successful burns (table 2). Forb and grass cover was minimal in all areas.

There appears to be a narrow separation between conditions necessary for prescribed burning which will adequately carry a fire and those of a wildfire which develop concern

toward suppression. The score of 130 appears to be close to this separation point. Of those burning attempts made during the project, conditions above 131 were not tested and no fires became dangerous or burned excessive acreages beyond the expected limits.

It is certain there are numerous and more complex variables involved in fire spread potential; however, this simple score seems to work as a general rule of thumb and it provides a guide for the land manager.

CONCLUSION

Land managers wanting to do out-of-fire-season burning are sometimes reluctant because they are not sure of the conditions needed to carry a fire. Many times, a day is spent in preparation and travel to the proposed burn site only to find that conditions are not adequate to carry a fire. A simple rule of thumb would aid in this burn or no-burn decision. The managers needs to know only the sum of the maximum windspeed in miles per hour, the air temperature in degrees Fahrenheit, and the percent vegetative cover (mi/h + °F + percent veg. cover = score) to predict if his fire will be successful.

A score of less than 110 will not provide conditions necessary for burning. A score of 110 to 125 indicates conditions prevail for burning; however, the area will need to be continually reignited during the entire burn period and unburned islands will occur. A score of 125 to 130 is optimum. After the ignition area is lit, the fire will carry by itself burning the area clean, with only some reignition necessary. A score above 130 indicates a hazardous condition in the scattered and dense pinyon-juniper communities when burning should not be attempted.

If the percent cover of vegetation is measured prior to burning and the desired wind direction is known for ignition points, the manager can predict his chances for a successful burn from the daily weather forecasts.

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KEYWORDS: Pinyon-Juniper ecology, prescribed fire, burning technique

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